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ABSTRACT

Comprehensive Achievement Monitoring (CAM) is a system designed to provide a curriculum defined in terms of performance objectives, test items to measure student performance on each objective, a set of comparable test forms to evaluate performance, testing throughout the period of course, computerized analysis and reporting of results after test administration, interpretation of results by teachers and students leading to decisions on curriculum and study priorities, and modification of curriculum, instructional activities, and CAM. This report offers the CAM philosophy, discusses the five different types of computerized feedback--individual student reports, group summary reports, teacher summary reports, form analyses, and curriculum analyses--and provides examples of each. The CAM data processing system is detailed, and then the CAM program in mathematics at Ravenswood High School (1970-1973), the CAM program for earth science at San Carlos High School (1969-1973), and the CAM program in basic comprehension skills in reading at Woodside High School are described. (SH)

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COMPREHENSIVE ACHIEVEMENT MONITORING IN THE SEQUOIA UNION HIGH SCHOOL DISTRICT

SYMPOSIUM
CALIFORNIA EDUCATIONAL DATA PROCESSING ASSOCIATION
December 8, 1972

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CAM PHILOSOPHY

For some time it has appeared necessary to refocus the direction that educational research has taken over the years. For many years educational research has emphasized tightly controlled experiments in which only one variable at a time is manipulated in experimental groups, while control groups are maintained as static as possible without manipulation.

Educators have tried to control many different variables in an attempt to isolate a single variable that might have some causative effect on student performance. Most generally this approach has been a dismal failure. One has only to examine the literature on any particular problem to note that for most problems there appears to be no clear cut solution. Experiments on the same problem have produced as many neutral and negative results as positive results.

It's not difficult to understand the reason for this. In almost any experimental situation the researcher will try to control as many variables as possible. The irony in an educational setting is that there are too many variables to control. Among these variables are the students, the instructional material, the teachers, time of day, length of class time, number of students, instructional strategies, reinforcement patterns etc. The dynamics of classrooms, however, quite often preclude successful experimental control really being achieved.

As one solution to improving experimental control, good research design advocates randomization of students into experimental and control groups. This is often difficult to achieve. If you structure the school just for experimental purposes you often disrupt teachers. If you try to randomly change the structure for different experiments, management of the

school becomes more difficult. One compromise solution that is used is randomization by classes. Classes, however, often are not uniformly heterogeneous in composition.

Recently educational researchers have begun to explore the possibility of using multivariate statistical analysis as a way to circumvent the problem of controlling variables. This technique shows promise but many of the procedures and applications still have to be developed before wide spread implementation of this approach will occur.

While the previous considerations concerning educational research and evaluation are certainly important ones, perhaps the most important one that any educational researcher should be cognizant of is the effect his work has upon the classroom teacher in terms of disrupting classroom routine. Educational research must be recognized as an instructional intervention in the classroom. The most commonly recognized and quoted research effect that is guarded against, or to which abnormally good results are sometimes credited, is the Hawthorne effect. The very introduction of the research effort with its attendant publicity and hoopla, often creates a short term benefit that is measureable and significant. There is an alternative negative effect that educational research and evaluation can impart to a classroom. It can disrupt the daily routine and operation of the classroom, upsetting both the students and the teacher. Educational researchers and evaluation people quite frequently are hit and run artists who totally disregard this aspect of their total responsibility.

Today's society is demanding that much more emphasis be placed on evaluation. This emphasis gives educational researchers and evaluators

more status in their attempt to document the learning process, and the effectiveness of educational systems. What they often forget, however, as they focus on finding a solution to some educational problem, is that any treatment is only as good as the person who is using it. If research and evaluation are indeed to become a panacea for improved education then teachers must become experimentalist and empirical in their decision making. Teachers must be directly involved in research to make it a living, functional part of today's educational process rather than some educational researcher's ego trip collecting dust on university library shelves or ERIC microfiche.

As it is conceived by the Sequoia Union High School District, Comprehensive Achievement Monitoring is a tool that enables teachers to function as researchers and evaluators. Its concepts include a curriculum defined by performance objectives. These objectives serve as discrete items to be studied in curriculum product research, or as the focus for educational process research. In fact their measurement is a partial indication of the success of the educational establishment. Each performance objective is measured by test items that teachers write to measure student performance on that objective. Thus the CAM system, through its test items, more truly reflects what the teacher wants a student to know than some externally created standardized test.

Sets of interchangeable test forms are created for each test. Sampling techniques are used to get estimates of what students know or are able to do without subjecting them to long involved testing situations that turn them off. No student has to respond to all the questions that have to be asked in order to furnish the teacher, who is the researcher, with all the information he needs. Thus that very important factor of class disruption is kept to a

minimum. Furthermore since the data being collected is relative to the class's regular curriculum, there is no need to add extra tests to the classroom schedule just to satisfy some externally located educational researcher.

Two other concepts of CAM are periodic testing, usually weekly or biweekly as determined by the teacher, and the storage of the collected information so that a longitudinal history of performance is the result. This approach builds a data bank that continually can be tapped for information concerning individual students and groups of students, all the time being unobtrusive and part of the regular classroom routine. The massive task of data collation and data storage is done by computer. Without a computer the approach toward research and evaluation that has been described would be physically impossible.

If teachers are to function empirically they must have at their disposal quick feedback of information. It is ver difficult to modify curriculum and instructional activities, or to work with students individually, without instant access to data. Reporting of results to the specification of the teacher is another concept of CAM. Computerized analysis and reporting is generally available on an overnight basis.

Each of the above concepts is being implemented to construct a complete evaluation cycle. We hope evaluation will become a continuous process in which the teacher uses a constant feedback of information to improve student learning. Naturally there is a possible weak link in the cycle. Teachers must have a great amount of knowledge to implement CAM before they can use it effectively to make decisions about curriculum, instructional activities, and students. The tool, CAM, can only be as good as the teacher who uses it. If a teacher cannot successfully master CAM concepts and interpret the results

that CAM produces, then the evaluation cycle will never be completed by that teacher.

To encourage teachers to use data in their daily instructional decision making we have asked them to define a particular problem that they are interested in exploring and establish an hypothesis thay they would like to test. We don't require that this hypothesis be concerned with the total problem of the effectiveness of CAM. We hope if teachers select an hypothesis that they they will study the data after each test administration in an attempt to discover whether their hypothesis is true. Perhaps they will even try to positively affect the hypothesis by what they do in the classroom. At that point they will be using CAM data as an everyday part of their teaching operation and the evaluation cycle will be closed. Evaluation will become functional and formative.

What does this mean to educational researchers? Teachers need assistance. Most of them are well read only in their subject matter field, but they generally are creative. They need to be stimulated concerning the possibilities for what they can do within their classroom. Educational researchers can serve as tutors and guides to teachers. But they must always keep in mind that unless the teacher enthusiastically embraces what the educational researcher is saying, then the researcher will be an albatross. The teacher is probably the most important variable in today's schools. What works for one teacher may not for another, and that is the most important thing for each teacher and researcher to discover. By focusing our efforts on the classroom teacher, rather than intellectually exciting theories or ideas, we hope to eventually build a mosaic that will give us answers to problems facing education.

At present during the first semester of 1972-73 sixty-five courses are being monitored by CAM. Many content areas are represented with courses in algebra, arithmetic, pre-algebra, general math, biology, chemistry, physics, general science, earth science, health occupations, geography, economics, government, social psychology, anthropology, social studies, basic skills, history, safety education, child development, reading, vocabulary, English, music, art, physical education, metal work, drafting, foods, Spanish, French, business law, marketing, accounting, and typing. One hundred and two teachers and approximately 7,116 students currently are participating in the program. These students come from 299 class sections. As of November 30, 32,814 CAM student tests have been processed along with standardized tests for 780 students, experimental tests for 631 students, counselor questionnaires from 506 students, and student assessment of teacher responses from 4,070 students. The latter processing represents prototype work done in CAM applications that are under development.

II CAM COMPUTERIZED FEEDBACK

There are five basic types of computerized feedback: individual student reports, group summary reports, teacher summary reports, form analyses, and curriculum analyses.

Figure 1 is an example of an individual student report. Each student receives a copy of his own student report after each test administration. The data shown in Figure 1 is for Tim Boetticher's second test administration. The left portion of the report tells the student for each item on the test what objective the item was associated with, whether each item on the test was right (+) or wrong (-), and if instruction was completed on that objective (YES). The right portion of the student report summarizes the student's performance on the present test administration and all previous test administrations. He is given two scores, the percentage correct on the total test and the percentage correct on those objectives with instruction completed.

A teacher summary report is shown in Figure 2. This report provides the teacher with each student's performance on each test administration, the test form the student was administered on each test administration, the cumulative average for each student on all test items thus far (TOT) and the cumulative average for all items for which instruction was completed prior to the test administration (YES).

The Group Summary Report is used to present percentage correct for any specified set of objectives, e.g., unit or all objectives, for any specified group of students. Each teacher usually gets one group summary for all students in the course, one for all his students,

and one for each class of his students. The Group Summary Report shown in Figure 3 is for Mr. Castoro's class that meets during Period 7.

The Group Summary Report also shows the performance of the students on each objective. From this report Mr. Castoro will realize that he needs to do some extra work with the students on Objective 107 since the student performance (15%) was fairly low relative to the other objectives.

An example of a form analysis is shown in Figure 4. After each test administration, the teacher receives a form analysis for each form used during that test administration. The response data from all students in the course who received that form are included in the analysis. The print-out shows the objective number, the correct response alternative, the average percentage correct, and the percentage of students who chose each response for each item on the test form.

A copy of a portion of a Curriculum Analysis is shown in Figure 5. This analysis can be requested by the teacher at any point in time, usually at the end of a quarter or semester. On this report the percentage correct and the percentage of students responding to each response alternative is shown for each item and each objective as a function of when the item was administered. Thus, the teacher is able to determine how the students performed prior to instruction (Pre), immediately following instruction (Post = 0 to 20 days), and on a long-term retention basis (Retention = longer than 20 days since instruction). The teacher has the option of determining how many days must have elapsed since instruction for performance data to be considered as a reflection of long-term retention.

BOETTICHER TIM W 330183 PERIOD 7 CASTORO 09/27/72
MA210

TEST ADM 2 - 9/25/72
PERCENTAGE CORRECT ON ALL ITEMS IS 70 FORM 20
PERCENTAGE CORRECT ON YES ITEMS IS 82

QN	OBJ	RP	INS	QN	OBJ	RP	INS
1	101	$-	YES	26	201	$+	YES
2	101	$+	YES	27	201	$+	YES
3	102	$-	YES	28	201	$+	YES
4	102	$+	YES	29	202	$+	YES
5	103	$+	YES	30	203	$+	YES
6	103	$+	YES	31	203	$+	YES
7	104	$+	YES	32	204	$+	YES
8	104	$+	YES	33	204	$+	YES
9	105	$+	YES	34	204	$+	YES
10	105	$+	YES	35	205	$+	YES
11	106	$+	YES	36	206	$+	YES
12	106	$+	YES	37	206	$+	YES
13	107	$-	YES	38	206	$+	YES
14	107	$-	YES	39	206	$-	YES
15	108	$+	YES	40	206	$+	YES
16	108	$+	YES	41	301	$-	
17	108	$+	YES	42	301	$+	
18	110	$+	YES	43	302	$-	
19	110	$+	YES	44	402	$-	
20	110	$+	YES	45	403	$+	
21	111	$+	YES	46	501	$-	
22	111	$+	YES	47	502	$-	
23	112	$+	YES	48	504	$-	
24	112	$+	YES	49	507	$-	
25	201	$-	YES	50	509	$-	

TEST ADM	FORM	PCT COR TOTAL	PCT COR YES
1	2	34	0
2	20	70	82
CUM AVG		52	82

Figure 1. A copy of an individual student report.

COMPREHENSIVE ACHIEVEMENT MONITORING - TEACHER SUMMARY REPORT MA210

M-A MEDICAL CAREERS PERIOD 7 TNB 16 CASTORO

09/27/72

NUMBER	NAME		CUM AVG	TEST ADMINISTRATION 1	2	3	4	5	6	7	8	9	10
329581	BATTON BONITA L	TOT	56	36	76								
		YES	82	0	82								
		FORM		1	20								
329805	BENTLEY SUSAN M	TOT	44	24	64								
		YES	72	0	72								
		FORM		2	20								
330183	BOETTICHER TIM W	TOT	52	34	70								
		YES	82	0	82								
		FORM		2	20								
333310	DICARLO BARBARA	TOT	51	28	74								
		YES	80	0	80								
		FORM		3	20								
333443	DORSEY DOLORES	TOT	40	28	52								
		YES	62	0	62								
		FORM		2	20								
335604	GRUYTER FRANCES C	TOT	50	30	70								
		YES	77	0	77								
		FORM		2	20								
337477	JOHNSON CINDY M	TOT	56	32	80								
		YES	90	0	90								
		FORM		1	20								
338566	LEE LAIOPING	TOT	50	32	68								
		YES	70	0	70								
		FORM		1	20								
340323	MONTGOMERY KATHY A	TOT	67	46	88								
		YES	97	0	97								
		FORM		3	20								
666727	MORRIS DENISE	TOT	51	40	62								
		YES	72	0	72								
		FORM		3	20								
342014	PORATH DARLENE E	TOT	58	46	70								
		YES	77	0	77								
		FORM		3	20								
344440	SNYDER SANDRA	TOT	56	38	74								
		YES	80	0	80								
		FORM		1	20								
345546	TIRTOPRODJO LESTARI	TOT	41	20	62								
		YES	67	0	67								
		FORM		3	20								

Figure 2. A copy of a Teacher Summary Report

COMPREHENSIVE ACHIEVEMENT MONITORING - GROUP SUMMARY REPORT MA210

M-A MEDICAL CAREERS 09/27/72

STUDENT GROUP 1607 CASTORO PERIOD 7

CGN	CONTENT GROUP		TEST ADMINISTRATION 1	2	3	4	5	6	7	8	9	10
	NUMBER OF STUDENTS		13	13								
0	ALL OBJECTIVES	AVG	33	70								
		NUM	650	650								
1	UNIT 1	AVG	53	81								
		NUM	47	312								
2	UNIT 2	AVG	36	73								
		NUM	44	208								
3	UNIT 3	AVG	30	43								
		NUM	26	39								
4	UNIT 4	AVG	23	34								
		NUM	17	26								
5	UNIT 5	AVG	25	36								
		NUM	74	65								
101	OBJECTIVE 101	AVG	$$$	76								
		NUM	4	26								
102	OBJECTIVE 102	AVG	$$$	73								
		NUM	4	26								
103	OBJECTIVE 103	AVG	$$$	88								
		NUM	5	26								
104	OBJECTIVE 104	AVG	$$$	96								
		NUM	4	26								
105	OBJECTIVE 105	AVG	$$$	80								
		NUM	5	26								
106	OBJECTIVE 106	AVG	$$$	88								
		NUM	5	26								
107	OBJECTIVE 107	AVG	$$$	15								
		NUM	4	26								
108	OBJECTIVE 108	AVG	$$$	89								
		NUM	4	39								
110	OBJECTIVE 110	AVG	$$$	94								
		NUM	5	39								
111	OBJECTIVE 111	AVG	$$$	100								
		NUM	4	26								

Figure 3. A copy of a Group Summary Report.

COMPREHENSIVE ACHIEVEMENT MONITORING - FORM ANALYSIS REPORT

M-A MEDICAL CAREERS MA210 09/27/72

FORM 20 13 STUDENTS RESPONDED TO THE FORM DURING TEST ADMINISTRATION 2

QUESTION NUMBER	OBJECTIVE	ANSWER	AVG SCORE	RESPONSES(%) NR	1	2	3	4	5
1	101	2	69	0	30	69	0	0	0
2	101	5	84	7	0	0	0	7	84
3	102	3	61	0	30	7	61	0	0
4	102	2	84	0	15	84	0	0	0
5	103	1	84	0	84	0	0	15	0
6	103	2	92	0	7	92	0	0	0
7	104	3	92	0	0	0	92	7	0
8	104	1	100	0	100	0	0	0	0
9	105	2	76	0	0	76	23	0	0
10	105	1	84	0	84	15	0	0	0
11	106	2	84	0	15	84	0	0	0
12	106	3	92	0	7	0	92	0	0
13	107	1	23	0	23	53	7	15	0
14	107	2	7	0	53	7	7	30	0
15	108	3	92	0	0	0	92	7	0
16	108	4	92	0	7	0	0	92	0
17	108	2	84	0	7	84	7	0	0
18	110	2	92	0	7	92	0	0	0
19	110	3	92	7	0	0	92	0	0
20	110	1	100	0	100	0	0	0	0
21	111	2	100	0	0	100	0	0	0
22	111	3	100	0	0	0	100	0	0
23	112	4	84	0	15	0	0	84	0
24	112	2	69	0	0	69	23	0	7
25	201	4	23	0	23	53	0	23	0
26	201	4	92	7	0	0	0	92	0
27	201	4	69	7	15	7	0	69	0
28	201	1	92	0	92	0	7	0	0
29	202	2	61	7	0	61	23	7	0
30	203	4	100	0	0	0	0	100	0
31	203	4	23	0	53	7	15	23	0
32	204	2	61	7	23	61	0	7	0
33	204	1	100	0	100	0	0	0	0
34	204	1	84	0	84	0	0	15	0
35	205	3	76	7	7	0	76	7	0
36	206	2	84	7	0	84	0	7	0
37	206	2	92	7	0	92	0	0	0
38	206	4	61	0	0	38	0	61	0
39	206	3	61	7	23	7	61	0	0
40	206	2	84	0	15	84	0	0	0
41	301	2	7	0	0	7	61	30	0
42	301	4	69	7	15	0	7	69	0
43	302	3	53	23	7	0	53	15	0
44	402	3	53	7	0	30	53	7	0
45	403	3	15	7	46	30	15	0	0
46	501	1	38	0	38	7	30	23	0
47	502	3	15	7	15	15	15	15	30
48	504	5	38	7	15	7	30	0	38
49	507	2	38	7	30	38	7	15	0
50	509	2	53	7	0	53	7	15	15

PCT COR = 70

Figure 4. A copy of a form analysis report.

COMPREHENSIVE ACHIEVEMENT MONITORING --- CURRICULUM ANALYSIS PROGRAM

SAN CARLOS EARTH SCIENCE 06/01/72
SAN CARLOS EARTH SCIENCE CURRICULUM ANALYSIS
UNIT 2300

PRE = -999 TO -1 DAYS POST = 0 TO 20 DAYS RETN = 21 TO 9999 DAYS

	ITEM NUMBER	COR ANS		TOT RESP	PCT COR	RESPONSES(%) NR	1	2	3	4	5
	230101	3	PRE	23	34	13	0	4	34	47	0
			POST	44	27	0	13	15	27	43	0
			RETN	27	48	3	7	0	48	40	0
	230102	2	PRE	21	23	9	28	23	4	33	0
			POST	48	68	2	8	68	6	14	0
			RETN	93	60	2	15	60	0	22	0
	230103	4	PRE	94	38	9	2	22	18	38	9
			POST	49	51	4	4	20	14	51	6
			RETN	23	56	4	8	13	13	56	4
	230104	4	PRE	29	41	6	6	34	6	41	3
			POST	44	34	0	11	45	9	34	0
			RETN	88	54	1	5	36	2	54	0
OBJ	2301		PRE	167	36						
			POST	185	45						
			RETN	231	56						
	230201	4	PRE	29	24	6	34	24	6	24	3
			POST	49	20	2	38	34	4	20	0
			RETN	90	25	1	27	42	3	25	0
	230202	2	PRE	69	53	15	2	53	15	11	0
			POST	0	0	0	0	0	0	0	0
			RETN	0	0	0	0	0	0	0	0
	230203	2	PRE	48	27	10	25	27	22	14	0
			POST	92	53	0	25	53	11	9	0
			RETN	119	36	0	31	36	22	8	0
	230204	3	PRE	23	26	13	17	8	26	34	0
			POST	44	54	2	13	6	54	22	0
			RETN	27	51	0	22	7	51	18	0
OBJ	2302		PRE	169	37						
			POST	185	44						
			RETN	236	34						

Figure 5. A copy of a Curriculum Analysis Report.

CAM Data Processing System

1. Test Construction

In the CAM system, the teachers select the test items that appear on each test form. From their item bank, this selection process is often done on a stratified random sampling basis within a specific content area. A management system was developed to enable the CAM staff to construct the tests during the year. The test construction phase of the CAM processing system currently supports 65 courses, 8,850 objectives, and 34,130 test items. The test items are typed on 5" x 8" cards and are filed by course. Through November 30 of the 1972 fall semester, 655 test forms averaging 7 pages each have been constructed. Teachers are encouraged to develop new test forms during the year on the basis of their CAM output. The test production operation includes a procedure to generate the answer keys that are input into the computer. The test construction process has not been computerized because:

1. Our line printer contains only capital letters;
2. Diagrams are used extensively in test items;
3. Data entry costs would be very expensive;
4. There were no resources available to develop the necessary software; and
5. A review of other test construction projects indicated serious problems with the concept of a computerized test item bank.

However, in the future we may develop software to have the computer construct tests for certain courses having only alphabetic items. An example of such a course is vocabulary.

2. Test Reproduction

Once the test forms have been constructed they must be reproduced. We have been using three techniques: Xeroxing, cutting a Gestetner stencil, and using an offset press. It is anticipated that most of the test reproduction will be decentralized to the schools during the next year.

3. Student Response Mechanism

Anticipating a large volume of test data requiring high accuracy, the student response mechanism is very important to the CAM system. It was decided that the student identification number, the student name, the class number, and the test form number must be prepunched or coded onto the student response mechanism. Keypunching is too slow and expensive. Optical scanning has not been used because of the time required to preslug the answer sheets, and the cost of the optical scanning and related equipment. Two marksensing techniques are available on the commercial market - Hewlett-Packard and IBM. The Hewlett-Packard marksensing device was not used because punched holes and pencil marks are read in the same spaces, and only one side of the card can be read when punched holes are in the card. We are using the IBM marksensing technique which enables us to read pencil marks on both sides of the card separately from punched holes. If used properly, the IBM 514 or 519 reproducing punch provides an inexpensive, accurate, and fast mechanism for converting student responses to a machine readable form.

4. Computer Hardware

The Sequoia Union High School District has a Hewlett-Packard minicomputer for instructional use. During the day the hardware listed below is configured as a 2000-E timesharing system that supports up to 16 terminals using BASIC. At 3:30 P.M. the hardware is configured as a 2120 disk

operating system to process CAM data. The basic hardware includes:

1. 2100-A Central Processor with 48-K bytes of core
2. 7900-A Moving Head Disk with 5M bytes of storage;
3. 2879-A 600 card per minute punched hole card reader
4. 2767-A 80 column line printer that runs at 355 to 1100 lines per minute.

5. Computer Software

The main CAM software system, called CAM2, is written in FORTRAN and has been operational since last March. The system includes its own sorting routines and several output format options. The data base is structured on a course by course basis. From 500 to 700 students can be stored on a disk platter. Each course can have answer keys for 50 test forms and 20 test administrations are allowed per student in a course. All student responses are stored on the disk by the CAM2 system so that other programs can access the data base to prepare special reports and analyses for the student, teacher, parent, researcher, and administrator.

Current software development includes a questionnaire analysis system, a standardized testing system, and a district wide instructional data base system.

6. Conclusion

The CAM data processing system is centralized in the district offices. This causes some problem concerning the delivery of materials from the schools to the central office and their return back to the schools. Fortunately, the district is geographically compact and the delivery problems

have been worked out. However, in larger districts these delivery problems could be more serious. An obvious solution to this delivery problem is using computer terminals as an input/output device. We do not foresee the use of terminals in the CAM system for the next few years for the following reasons:

1. As we continue to develop new products and techniques, we insist upon a quality control element. Presently we could not maintain this quality control at each of the six schools.

2. The equipment required to run CAM via terminals would be significantly more expensive than our present computer hardware. On line disk storage and data entry devices might double the current hardware costs.

3. The amount of data output would be seriously limited using voice grade phone lines and standard terminal output devices.

Using CAM In Mathematics At Ravenswood High School

Harold McCann

Our first CAM evaluation design was developed at Sequoia High School in 1970-71 to monitor a basic mathematics course that was a performance-contract, student-paced program. In 1971-72 we moved to Ravenswood High School and added a course in Pre-Algebra monitored by CAM. During the summer of 1972 a major revision of both these courses was made, and three more courses were developed for CAM monitoring. For the 1972-73 school year we have 4 sections of Basic Math, 4 sections of General Math, 4 sections of Pre-Algebra, 5 sections of Algebra I and three sections of Algebra II, all using CAM evaluation techniques. Three of the five teachers in the department have participated in the development and writing of CAM designs and all five are participating users.

In Basic Math, the course design consists of a series of 8 booklets covering the basic operations of mathematics for whole numbers and a cursory skimming of work with rational numbers and integers. The original evaluation design is shown in Table 1.

Table 1

Components of the Original Design for Basic Math

	Block			
	1	2	3	4
Booklets	1,2	3,4	5,6	7,8
Number of objectives	25	22	21	19
Number of test forms	7	7	7	7
Number of posttest items	25	22	21	19
Number of retention items	0	5	9	11

In the summer of 1971 a minor revision was made. The final overall achievement level for all students was 56%. During the year overall achievement consistency had centered around 60%. Using this as a criterion we examined all objectives with an overall achievement of less than 60%. We identified four objectives as too difficult for students with this ability-level and therefore discarded them. For six additional objectives it was determined that the test items were poorly stated and so these were revised.

All test items in the original design were short-answer type questions. All tests were corrected by the teacher and mark-sense cards were marked for right or wrong responses. The Pre-Algebra course that was added the second year used the same techniques.

In the spring and early summer of 1972 the results of the program were analyzed and the following conclusions were made.

1. Short-answer items required an excessive amount of teacher time to evaluate responses.

2. Learning activities for some objectives were repeated in subsequent booklets and were not being tested at the point of reoccurence.

3. Students were assigned learning tasks which were irrelevent to the objectives and were also doing activities which they mastered prior to entry in the course.

4. Retention data showed a high level of student achievement and this makes the need for retention data less important.

5. Entry-level achievement for some objectives was high, in some cases exceeding 80% and discussion among the teachers involved felt that additional objectives were needed in the area of rational numbers.

Therefore a major revision of Basic Math and Pre-Algebra was accomplished and the course in General Math was added. The revision embodied the following major changes.

1. In Basic Math five more objectives were eliminated. Some of these had been considered borderline in the previous revision but had been retained pending additional data. Also, a large number of Pre-Algebra objectives were too difficult and were eliminated.

2. An extensive item rewriting project was undertaken and an effort was made to change to a multiple-choice format.

3. The objective hierarchy was changed and all objectives were tested at point of occurence in the sequence of learning objectives.

4. An effort was made to simplify the remedial prescription process. In the original effort a special CAM computer program had been written to prescribe remedial lessons for those students not performing certain objectives. In the revision the objectives in Basic Math were coded so that the remedial prescription was part of the objective number, e.g., Objective 1021 indicates the learning activity is in Book 1, Lesson 2.

5. Two units were added to the Basic Math curriculum to give further learning in the field of rational numbers.

6. The evaluation design for all three courses was as shown in Figure 1.

One of the salient features of the program in Basic Mathematics, General Math, and Pre-Algebra has been what we call mastery-learning. It was our premise that students should not have to do learning tasks for objectives which had already been mastered. Therefore, throughout the program we have employed the following technique.

1. On achievement of 90% the student will proceed to the next unit without performing all the activities of the unit in which mastery was demonstrated. Since 90% is a high standard we added the provision that acceleration would also occur with two consecutive scores of 75%.

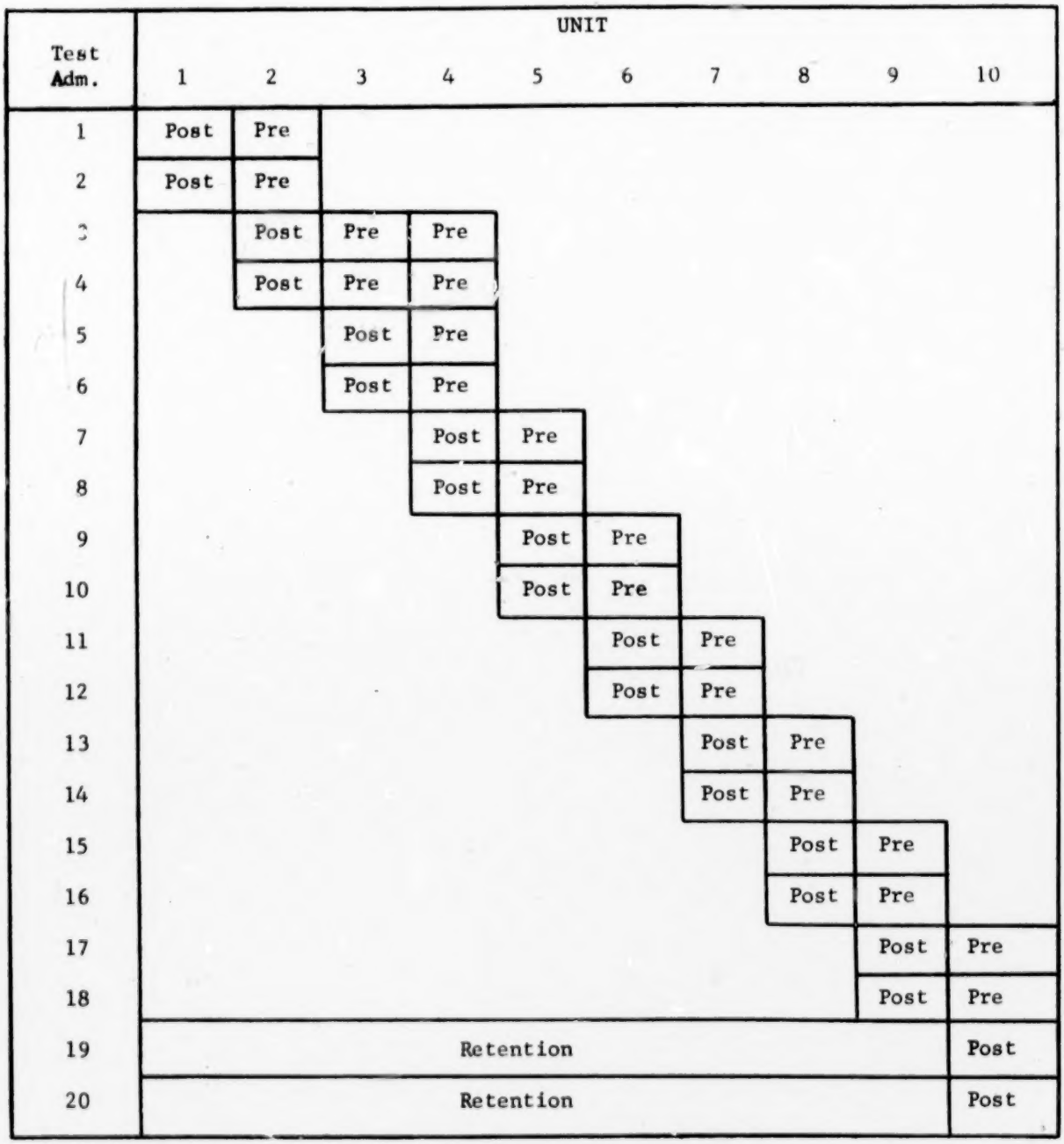

Figure 1. Evaluation design for Basic Math, Pre-Algebra, and General Math for the 1972-73 academic year.

2. A student should not have to perform learning tasks for objectives already mastered. Therefore, after each test administration a remedial prescription is given for objectives for which responses were incorrect.

In designing the evaluation systems for our Algebra I and Algebra II courses we drew on our experience and the data from the Basic Math and Pre-Algebra courses. We concluded the following:

1. It is not necessary to test every student on every objective. Thus, in both Algebra I and Algebra II, we are using extensive sampling techniques.

2. Retention data on already taught lower order objectives is of little relative value in Mathematics. It was our conclusion that objectives at the base of the structure were constantly being reinforced. Since these objectives at the base of the hierarchy are embodied in subsequent objectives, achievement is therefore reflected in the success on later objectives, e.g., success on the objective "You will correcely add two fractions with like denominators" requires mastery of the objective "You will correctly add a pair of whole numbers".

We have used CAM data to make changes in the structure and strategies of our teaching/learning environment. The results of group summary data are analyzed after each test administration. Students in the three courses Basic Math, General Math, and Pre-Algebra all have been enrolled in 4 basic time periods with students in all three courses in the same class grouping. This group of 30-40 students is supervised and tutored by two teachers, an adult paraprofessional aide, and two student tutors. After each test administration the teacher-team goes over the data attempting to find objectives which seem to be causing learning difficulties. We look for post-instruction data with less than 50% success and for objectives with a significant drop in achievement. Then a strategy discussion follows among the faculty. One of the following techniques may be used.

1. A lecture-demonstration for the whole group is scheduled.

2. Appropriate visual aids are prepared.

3. Additional drill material is prepared.

4. At least once this year it was decided to abandon the objective until another revision could be made.

In summary, the use of comprehensive achievement monitoring in the math program at Ravenswood High School has enabled us to:

1. Concentrate our teaching resources on assisting individual students and eliminate the necessity of time consuming record keeping activities.

2. Eliminate irrelevant learning tasks.

3. Allow students to concentrate on unlearned objectives rather than waste time on concepts and skills already mastered.

4. Allow some students to broaden their knowledge by turning to other areas since they may complete their math objectives in less than the 175 day school year.

5. Allow time for enrichment and recreational math activities.

Earth Science At San Carlos High School

Larry Wagner

For three years we have been trying to design an individualized Earth Science program that would provide for maximum student decision making as to topics studied and lessons completed. Our greatest limitations have been the restrictions imposed by the traditional bell schedules and a single classroom setting with no resource center space available for quiet uninterrupted study away from the lab.

During the summers of 1969-70 we developed individualized study packets containing performance objectives, learning activities, self tests, and post tests. During the 1970-71 school year students were free to select packets within each of the Earth Science content areas of Astronomy, Geology, Meteorology, and Oceanology. Each content area lasted one quarter. Based upon student feedback and CAM data we decided to modify the course design and change the evaluation procedures for the school year 1971-72.

The course design for 1971-72 was more traditional in that the students were group-paced but we still used the packets developed for 1969-70. CAM results indicated a greater increase in student performance than in the previous year. There were still students who wanted to move independently and they were given that option. However, we tried to keep the number of students working independently to a minimum to facilitate record keeping.

Keeping in mind that the group-paced instruction data showed greater increases in student performance than the self-paced instruction group of the previous year, we still recognized the need for many students to assume more responsibility and make more of their own decisions as to lesson selection and completion. We, therefore, revised the format for the 1972-73 school year to include a group/self-paced combination course and evaluation design as described below.

COURSE DESIGN

The astronomy section of the Earth Science course is composed of 88 instructional objectives which make up 23 lessons within the six astronomy chapters of the text. There are 2-7 lessons per chapter with an average of 3.8 objectives per lesson (from 2-5 objectives per lesson). The course design and evaluation design are shown in Table 1; the astronomy course outline is shown in Table 2 with examples of objectives shown in Figure 1. The students have been divided into three groups with each group corresponding to one class section. The course is group paced in terms of which chapter the students are studying, but is individually paced in terms of the lessons (order and number) within a chapter. The major differences among the three groups are:

Group 1 - the student decides which lessons he will study and when he has completed a lesson, i.e., when he is ready to take a CAM test on that lesson.

Group 2 - the teacher, based on results of CAM tests and on the Dubins Earth Science test, decides which lessons the student will study and the lesson or lessons he has completed.

Group 3 - the teacher, based on results of CAM tests and the Dubins Earth Science test, decides which lessons the student will study, but the student decides when he has completed a lesson.

In all instances where a student declares he has completed a lesson, he receives positive credit for completing objectives within a lesson on which he answers the test items correctly. If he gets these items wrong, he loses credit. The loss of credit policy was implemented to reduce the number of students who would declare a lesson completed hoping that they would get items correct by chance and thus receive credit for objectives completed. In addition, a student is allowed to repeat any test (another form) a second time. However, the score on the second testing replaces the score on the first testing even if the score is a lower one. Thus, the student hopefully is motivated to study some

Table 1

San Carlos Earth Science (Astronomy) Course and Evaluation Design

Chapter	Lesson	# Objs.	Test Adm.	Number of Items			
				Pre	Post	Ret	Total
			1	50			50
26	1	3					
	2	4					
	3	3					
	4	5	2	6	20	0	26
	5	4					
	6	5					
	7	5	3	10	15	8	33
27	1	5					
	2	4					
	3	3					
	4	3					
	5	3	4	8	25	6	39
29	1	3					
	2	4					
	3	4					
	4	4	5	6	20	10	36
30	1	2					
	2	4					
	3	5	6	8	15	8	31
31	1	5					
	2	2					
32	1	3					
	2	5	7	0	20	6	26
			8	0	20	30	50
Total	23	88					

Table 2

Astronomy Outline

Chapter 26 STARS AND GALAXIES
- Lesson 1 - Telescopes
- Lesson 2 - Spectroscopes
- Lesson 3 - Characteristics of stars
- Lesson 4 - Stellar color and temperature
- Lesson 5 - Stellar motions; variable stars; binary stars
- Lesson 6 - Galaxies
- Lesson 7 - Groupings of stars; nebulae

Chapter 27 THE SOLAR SYSTEM
- Lesson 1 - The sun
- Lesson 2 - The planets: recognizing and classifying
- Lesson 3 - The planets: orbits; shape, size, & density; rotation; atmosphere
- Lesson 4 - Asteroids; natural satellites; comets
- Lesson 5 - Meteors; meteoroids; meteorites; evening and morning stars

Chapter 29 OUR MOON
- Lesson 1 - Origin and characteristics of the moon
- Lesson 2 - The moon's motions
- Lesson 3 - The moon and eclipses
- Lesson 4 - Sun, moon, and tides

Chapter 30 EARTH'S MOTIONS
- Lesson 1 - Overview of the earth's motions
- Lesson 2 - Earth's rotation
- Lesson 3 - Earth's revolution

Chapter 31 LOCATION AND NAVIGATION
- Lesson 1 - Location (latitude and longitude)
- Lesson 2 - Navigation

Chapter 32 KEEPING TIME
- Lesson 1 - Units of time
- Lesson 2 - Time zones

TEXT: Earth Science - The World We Live In by Namowitz & Stone

DATE_____PERIOD_____

Chapter 26 - STARS AND GALAXIES

LESSON 6 - STELLAR EVOLUTION AND GALAXIES

Objective Number INSTRUCTIONAL OBJECTIVES

2661 - Identify the correct description and/or size of our galaxy.

2662 - Associate the name of the 3 main types of galaxies to a description or diagram.

2663 - Identify the density, composition and origin of the great gas and dust clouds of interstellar space.

2664 - Be able to identify characteristics of each stage in the life history of a star in terms of temperature, color, and size of the star, and relate the process to our sun.

2665 - Be able to select the correct explanations or sketches which stand for the following origins of the universe:
a. Expanding universe theory
b. Steady-state theory

ACTIVITY OBJECTIVES

2666 - (5) Complete the study guide on STELLAR EVOLUTION AND GALAXIES using your text and other books as references.

2667 - (5) LABORATORY ACTIVITY - COMPARING THE SUN WITH OTHER STARS. Perform the activity as described in the handout with the same name.

2668 - (5) LABORATORY ACTIVITY - INVESTIGATING GALAXIES. Perform the activity as described in the handout with the same name.

2669 - (20) ESCP READINGS FOR GREATER UNDERSTANDING

a. STELLAR EVOLUTION (10) - Read pages 536-543 and answer questions 1-5 page 544.

b. WE LIVE in a GALAXY (5) - Read pages 544-547 and answer questions 1-4 page 547.

c. OUR GALAXY AMONG ITS NEIGHBORS - Read pages 547-549 and answer (5) questions 1-4 page 549.

PEANUTS
SOME STARS ARE BIG AND SOME STARS ARE LITTLE
United Feature Syndicate, Inc. © 1958
YOU SURE KNOW A LOT ABOUT THE STARS LUCY.
WELL, I'VE DONE QUITE A BIT OF STUDYING..
ONE OF MY BEST SUBJECTS IN SCHOOL WAS AGRICULTURE!

Figure 1 . Example of objectives and activities for Lesson 6, Chapter 26.

more if he has chosen to take the test a second time.

EVALUATION DESIGN

The evaluation design used in the Earth Science course is made up of a "sliding-unit" CAM upon which is superimposed a content area "standard CAM". That is, each of the different test administrations has components related to retention, immediate post-instruction, and pre-instruction test items. The course and evaluation design in Table 1 shows the distribution of pre, post, and retention items.

On the sliding-unit CAM there are two items per lesson on lessons studied prior to the lessons currently being tested. There are five items per lesson on lessons just studied and two items per lesson on lessons to be studied next. Test administrations 2-7 represent sliding-unit CAMs and are administered every two to three weeks. Each test consists of two forms so that one-half of each class received each form. If a student repeats a test over, he takes the alternate form from the one he first took.

The standard CAM is made up of two forms that are given on test administration 1 and test administration 8. These two forms are each made up of questions randomly selected from the astronomy bank of items so that all lessons are sampled. Each student receives the form on test administration 8 that he did not receive on test administration 1.

CLASSROOM USE OF CAM RESULTS

Each student receives a copy of their individual print-out or student report form, as shown in Table 3, and a copy of his lesson completion summary form, as shown in Table 4. A glance at the lesson completion summary indicates the total number of post-instruction responses correct over the total number of questions asked on that lesson. If a student misses any of the questions for a given lesson he can then look at the specific objective number to see where the difficulty lies. For example, the student whose data are shown in Table 4 missed one question out of five in lesson 303. If you look at the

Table 3

Example of an Individual Student Report

KRAMER SCOTT L 105981 PERIOD 2 WAGNER 11/30/72
SC202

TEST ADM 6 - 11/29/72
FRACTION CORRECT ON ALL ITEMS IS 26/ 33 FORM 62
FRACTION CORRECT ON YES ITEMS IS 22/ 25

QN	OBJ	RP	INS	QN	OBJ	RP	INS
1	2751	$+	YES	18	3023	$+	YES
2	2753	$-	YES	19	3024	$+	YES
3	2911	$-	YES	33	3024	$+	YES
4	2913	$-	YES	20	3031	$+	YES
5	2921	$+	YES	21	3032	$-	YES
6	2924	$+	YES	22	3033	$+	YES
7	2931	$+	YES	23	3034	$+	YES
8	2933	$+	YES	24	3035	$+	YES
9	2941	$+	YES	25	3112	$-	
10	2942	$+	YES	26	3114	$+	
11	3011	$+	YES	27	3121	$+	
12	3011	$+	YES	28	3122	$-	
13	3012	$+	YES	29	3212	$-	
14	3012	$+	YES	30	3213	$+	
15	3012	$+	YES	31	3223	$-	
16	3021	$+	YES	32	3225	$+	
17	3022	$+	YES	34	0	$	

TEST ADM	FORM	FRN COR TOTAL	FRN COR YES
1	2	20/50	0/ 0
2	21	18/26	13/15
3	31	24/33	13/16
4	42	31/39	27/29
5	52	27/34	25/28
6	62	26/33	22/25
CUM TOT		146/215	100/113

Table 4

Lesson Completion Summary

KRAMER SCOTT L 105981 WAGNER PERIOD 2
11/29/72 SC202

LESSON	DATE COMPLETED	PRE-INS RESPONSES	POST-INS RESPONSES
261	9/22/72	0/ 2	7/ 7
262	9/22/72	2/ 2	7/ 7
263	9/22/72	0/ 2	6/ 7
264		6/ 9	0/ 0
265	10/ 6/72	1/ 4	4/ 7
266	10/ 6/72	2/ 5	6/ 7
267		7/11	0/ 0
271	10/25/72	1/ 5	7/ 7
272	10/25/72	4/ 4	7/ 7
273	10/25/72	2/ 4	6/ 7
274	10/25/72	1/ 4	7/ 7
275	10/25/72	1/ 4	6/ 7
291	11/ 9/72	2/ 4	4/ 7
292	11/ 9/72	3/ 4	7/ 7
293	11/ 9/72	0/ 4	7/ 7
294	11/ 9/72	0/ 4	6/ 7
301	11/29/72	1/ 4	5/ 5
302	11/29/72	4/ 4	5/ 5
303	11/29/72	2/ 4	4/ 5
311		1/ 5	0/ 0
312		2/ 4	0/ 0
321		2/ 4	0/ 0
322		2/ 5	0/ 0
TOTALS		46/102	101/113

TOTAL POINTS 178

student report form shown in Table 3 you will see that he missed objective 3032. If students conscientiously review their printouts and study their objectives they cannot help but succeed.

RESULTS

Since the astronomy unit has been thoroughly revised this year, there is not yet enough data for a complete comparison with the student performance of the past few years. We can, however, compare the percentage correct on all objectives for each of the first four test administrations for the Fall terms of 1970, 1971, and 1972. These data are shown in Table 5 with the 1972 data grouped according to the decision strategy used in the classroom. The gain in percentage from test administration 1 to test administration 4 had increased over the three years.

The data in Table 6, taken from a later test administration, allows a comparison among the years based on content material that was the same during all three years. Again, the students increase in performance from the pretest is greater in 1972 than it was in either 1970 or 1971, for Groups 2 and 3. Group 1, the group in which the students are allowed to choose both the lessons they study and when they have completed a lesson, did not show gains appreciably different from the groups in 1970 or 1971.

Table 5

Comparison of Percentage Correct on all Objectives for Earth Science Students

Test Adm.	Fall 1970		Fall 1971		Fall 1972 Group 2		Fall 1972 Group 1		Fall 1972 Group 3	
	%	#	%	#	%	#	%	#	%	#
1	48	432	30	523	29	1450	32	1650	24	1300
2	47	432	44	540	68	369	65	504	59	392
3	54	468	49	660	60	633	66	665	55	456
4	56	486	53	560	67	519	63	718	58	604
Gain in %	8		23		31-44*		31-34*		31-42*	

* Calculated as the range of the changes from TA1 to TA 2, TA 1 to TA 3, and TA 1 to TA 4.

Table 6

Comparison of Percentage Correct on Similar Topics in Astronomy

	Fall 1970			Fall 1971			Fall 1972								
							Group 2			Group 1			Group 3		
	Pre	Post	Gain	Pre	Post	Gain	Pre	Post	Gain	Pre	Post	Gain	Pre	Post	Gain
Lesson 301							31	64	33	31	53	22	19	49	30
Lesson 302	27	44	17	34	47	13	25	68	43	46	59	13	30	66	36
Lesson 303	44	60	16	42	53	11	32	60	28	39	57	18	35	52	17

CAM For Basic Comprehension Skills in Reading

William Johnson

A CAM instructional unit of objectives for reading comprehension was constructed at Woodside High School, aimed at solving the following problems:

1. Woodside needed articulated materials for students reading roughly at grade levels 6-9 in the heterogeniously-grouped reading lab;

2. Students reading at grade levels 6-9 were not showing grade level reading growth as great as those students learning the more basic decoding skills;

3. Commercially prepared kit materials did not specify a sequence of objectives aimed at providing a gradually more sophisticated comprehension ability;

4. Students plowing through comprehension exercises in kits were not getting enough specific feedback as to what they did or did not know--they were bored.

Scope of the Material

A sequence of 25 objectives was created to advance the student to comprehension skills of increasing sophistication. The first objectives ask the student to determine the definition of a specific word in context or complete a short passage, given a specific context clue. The final objectives of the course ask the student to determine organizational patterns or paragraphs such as cause-effect or comparison-contrast. More difficult inference skills, objectives in reading charts and graphs, or determining literary devices and techniques such as puns, or labeling the writer's style, were not included

as "Basic Comprehension". This term was restricted to mean the literal understanding of informative prose. Specific examples of other objectives are as follows: "Given a passage with pronouns underlined and numbered, the student shall choose from a list of possible referents, the correct referent of an indicated pronoun . . . Given some numbered statements which indicate a chronological sequence of activity, but presented in scrambled order, the student shall put the statements in correct chronological order by number . . . Given a paragraph, the student shall indicate if the passage demonstrates a simple listing pattern".

Teaching CAM Comprehension

The material was designed to be mastered in 9 weeks. The tactics for teaching this CAM material were small group instruction and plenty of reinforcement practice items done with the teacher. Between 5 and 10 students per class, reading roughly at grade levels 6-9 met 2 to 3 times a week with an adult instructor. These students had already achieved decoding and word attach skills. The testing procedure was to administer test items for all 25 objectives at each test administration. The initial plan specified 5 test administrations.

First results showed that we needed a massive overhaul of the project. After two test administrations, student performance dropped on many objectives, especially those not yet taught. The tests were too long and many students gave up, with the rationale that much of the material had not been taught to them. We concluded that in teaching basic reading skills the students must be presented with a strong success experience. We now give CAM tests only on material with which students have had ample practice with reinforcement exercises.

Other Problems

More reinforcement exercises were needed. Unfortunately, a single

reinforcement item for one objective may require the instructor's creating 25 to 50 words of prose just to get one response from the student. Students needed much more practice to master the objectives. Some objectives designed to prepare students for subsequent, more difficult objectives did not do so. Students mastered the preparatory objective but faltered with the more sophisticated.

The Overhaul

Sixty man hours were spent analyzing the data to improve the CAM Basic Comprehension design. The basic changes were:

1. The tests were shortened, often by as much as 15 items; we found that fewer items per objective were needed on a test to determine student competence.

2. The material was divided into four units, to be administered only after instruction on each unit had taken place; retention items on previously taught objectives were included for the 3 latter units. Two test forms, testing all objectives were retained to use as pre and post instruction tests.

3. Bad items were weeded out using the form analysis provided as regular CAM output.

4. Several objectives were eliminated as poor lead-ins to other objectives; three objectives were added to help prepare students for more sophisticated material.

5. An objective using vocabulary words from a program developed at San Carlos High was plugged in to provide student confidence with material they will have seen before.

Conclusion

The revised CAM Basic Comprehension material is now being taught

in three reading classes. Students have just taken their first unit test. Shorter tests have meant happier test experiences. The comprehension program will be field tested by four other schools this winter in a variety of classroom situations, including different reading lab set-ups and underclass English classes. Data from these schools should further influence design and perhaps specify a revised progression of objectives based on student performance.

CAM Basic Comprehension is in the process of becoming. If this creation were likened to a statue, it would still be in the quarry. Nevertheless, the design of the CAM instructional system allows us to continually reshape, modify, and perfect. Finally, the general absense of materials having a sound progression of reading skills based on prior field testing ofstudent performance, has encouraged me to use CAM data as feedback in developing my own materials.